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DYNAMICS AND TEMPORAL VARIATION IN AGE STRUCTURE AT A COMMUNAL ROOST OF EGYPTIAN VULTURES (*NEOPHRON PERCNOPTERUS*) IN NORTHEASTERN SPAIN

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The Egyptian Vulture (*Neophron percnopterus*) is a small vulture that occasionally gathers in communal roosts (Ceballos and Donázar 1990, Donázar et al. 1996). The existence of such roosts seems to be linked to abundant and regular food sources and also to the species' gregarious behavior under such conditions (Donázar 1993, Donázar et al. 1996). In small cathartid vultures, Rabenold (1983) has suggested that this behavior would be an adaptation in order to increase an individual's foraging efficiency on dispersed and unpredictable food supplies.

The Spanish population of Egyptian Vultures represents 80% of the total in the European Union, and has undergone a significant decline in recent years (Del Moral and Marti 2002). Communal roosts are thus important in terms of conservation, particularly bearing in mind that a large fraction of the preadult population concentrates in them (Donázar et al. 1996). The underlying causes leading to the formation and disappearance

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Table 1. Monthly variations in the number ($\bar{x} \pm$ SD) of Egyptian Vultures recorded at the roost between March and September 1998.

MONTH	TOTAL INDIVIDUALS (RANGE)	ADULTS (RANGE)	IMMATURE (RANGE)
March (N = 4)	0	0	0
April (N = 4)	1 ± 1.7 (0–4)	0.75 ± 1.3 (0–3)	0.25 ± 0.4 (0–1)
May (N = 6)	8 ± 5.6 (0–16)	2 ± 1.5 (0–5)	6 ± 4.3 (0–11)
June (N = 3)	17.3 ± 2.4 (14–19)	11.7 ± 2.1 (9–14)	5.7 ± 0.9 (5–7)
July (N = 5)	5.4 ± 3.5 (0–10)	3 ± 2 (0–6)	2.4 ± 1.6 (0–4)
August (N = 4)	13.2 ± 5.5 (6–21)	7 ± 3.7 (2–11)	6.3 ± 2.4 (4–10)
September (N = 2)	2.5 ± 2.5 (0–5)	1 ± 1 (0–2)	1.5 ± 1.5 (0–3)

of such roosts, the possibility that local variations exist, and the movement of birds between roosts (Donázar et al. 1996), are reasons that justify the need for further information on the structure and dynamics of such aggregations in this species.

In this paper we describe the results obtained during a study on the dynamics and temporal variation in age structure at an Egyptian Vulture roost in Catalonia (north-eastern Spain) carried out for two consecutive seasons. We also discuss the factors leading to its formation and disappearance.

STUDY AREA AND METHODS

The study was carried out in Catalonia, northeastern Spain. The breeding population of Egyptian Vulture in this region typically includes 34–40 pairs and its status has remained stable since the middle 1980s (D. García and A. Margalida unpubl. data). Even though the territories of breeding pairs have been monitored regularly, the first communal roost of this species in the area was not found until 1997 (Margalida 1997). Seven Egyptian Vulture pairs have their nests within a 10-km radius of the roost. Food availability is high and is a consequence of extensive livestock rearing of sheep, goats, and cattle (Margalida et al. 1997). The area where the roost is found has a mean annual rainfall of around 800 mm, with mean temperatures of 23°C (mean high) and 6°C (mean low). Dominant vegetation is of Mediterranean type with scattered forests consisting of white oak (*Quercus humilis*), holm oak (*Quercus ilex*), and Scotch pine (*Pinus sylvestris*).

In 1997, when the roost was formed, it was monitored weekly (Margalida 1997) and this was continued during 1998–99. Monitoring consisted of one visit per week for the period between March and September, with a total of 50 visits (28 in 1998 and 22 in 1999). June 1998, and April and August 1999 received only three visits each, which were spaced out every 10 d, so as to cover the whole month in a homogeneous way. In September, at the time of the post-breeding migration, observations were carried out during the first 10 days. In 2000, visits to the roost were carried out more or less sporadically until its disappearance was confirmed at the end of June.

Visits usually started in the early evening (1800 H, solar time), as birds began to arrive and settle in, and were carried out until dusk (1900–2000 H), when birds stopped flying in the proximity of the roost. The number and age of the birds present was recorded in every visit Age was established according to plumage following Ceballos and Donázar (1990), Tella (1991), and Donázar et al. (1996). Only two age categories were identified, because no young-of-the-year were found. These were: adults (individuals showing complete adult plumage, ≥4-yr birds) and immature (individuals showing some imperfection or with dark transitional plumage, 2-yr and 3-yr birds; Donázar 1993). Observations were carried out using 20–60× telescopes at a distance of over 500 m in order to minimize disturbance to the birds.

RESULTS

In the study area, arrival of the first breeding individuals took place on 5 March 1998 and on 26 February 1999. In 2000, the first individual was observed on 3 March. In 1998, the first birds (three adults and one immature) started using the roost on 28 April (previous observation with no birds seen was on 19 April), and in 1999 (11 adults plus one immature) on 26 April (during observations on 19 April no birds were seen). The last birds were seen at the roost on 1 September (two adults and three immature) in 1998 and on 11 August in 1999 (one adult and one immature).

Location of the sleeping vultures changed between the years. While in 1997 they chose to perch on Scotch pines, a birch (*Betula pendula*), and a white oak (Margalida 1997), in 1998 and 1999 they chose a small forest of oak and, later, an isolated black poplar (*Populus nigra*). The latter was used in all the observations between May and September. In 2000, all the observations were made on the same poplar that had been used in 1999. Distance between the roost and the nearest predictable food source (a rubbish dump where carcasses were available regularly) was of some 2 km.

Altogether, no differences were noticed in the number of birds using the roost in the two study years. In 1998, the maximum number of birds sleeping simultaneously at the roost was 21 on 7 August (Table 1). In 1999, the maximum number of birds was also 21, on 5 June (Table 2). However, both in 1998 and in 1999, the mean largest

Table 2. Monthly variations in the number ($\bar{x} \pm$ SD) of Egyptian Vultures recorded at the roost between March and September 1999.

MONTH	TOTAL INDIVIDUALS (RANGE)	ADULTS (RANGE)	IMMATURE (RANGE)
March ($N = 2$)	0	0	0
April ($N = 3$)	9.3 ± 6.8 (0–16)	5.5 ± 6.0 (0–11)	0.5 ± 0.8 (0–5)
May ($N = 5$)	7.4 ± 7.3 (0–21)	4.2 ± 3.7 (0–11)	3.2 ± 3.6 (0–10)
June ($N = 4$)	17.3 ± 2.6 (14–21)	11.3 ± 1.1 (10–13)	6 ± 3 (3–11)
July ($N = 4$)	11.5 ± 5.7 (2–17)	4.8 ± 2.3 (1–7)	6.8 ± 3.5 (1–10)
August ($N = 3$)	0.7 ± 0.9 (0–2)	0.3 ± 0.5 (0–1)	0.3 ± 0.5 (0–1)
September ($N = 1$)	0	0	0

number of birds using the roost occurred in June, with 17.3 ± 2.4 birds ($N = 3$) and 17.3 ± 2.6 birds ($N = 4$), respectively (Tables 1 and 2). In terms of age classes, the largest number of adults were seen in June of both years. In contrast, birds in non-breeding plumage mostly concentrated in roosts in August in 1998 and in July in 1999 (Tables 1 and 2). With respect to birds of breeding age, differences between the years were found in May, with higher numbers in 1999, and in August, with less birds in 1999 (Tables 1 and 2). Differences in the number of non-breeding individuals were found in August, with fewer birds in 1999 (Tables 1 and 2).

Ninety-five (50.3%) of the 189 birds seen in 1998 ($N = 28$ visits) were adult and 94 (49.7%) were immature (Table 1). In 1999, 108 (59.3%) of the 182 birds seen ($N = 22$ visits) were adult and 74 (40.7%) were immature (Table 2). No significant differences were found between the years with respect to the number of adult birds present vs. immature ($\chi^2_1 = 2.73$, $P = 0.099$). Monthly variation (using only the highest single count made in each month) in both years neither was statistically significant (1998: $\chi^2_5 = 5.93$, $P = 0.31$; 1999: $\chi^2_4 = 2.56$, $P = 0.63$).

In both 1998 and 1999 there was a very similar pattern in the percentages of adults and immatures present at the roost (Fig. 1) and significant differences were only

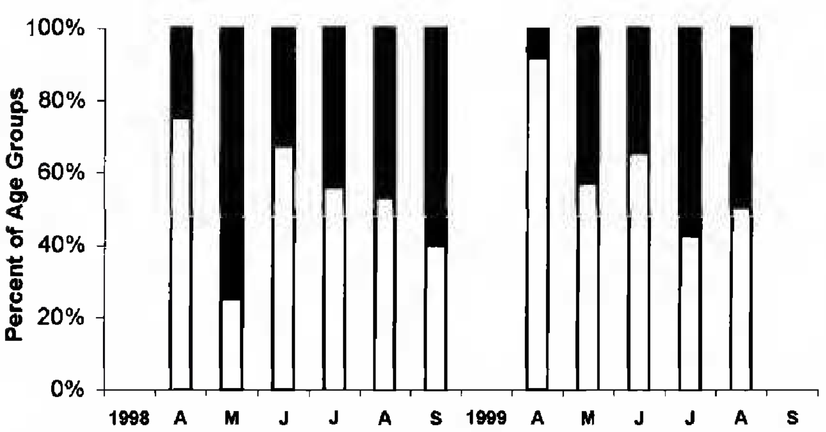

Figure 1. Monthly variation in the proportion of birds of breeding age (white bars) vs. birds of non-breeding age (black bars) during the period April–September of 1998 and 1999.

found in May, when the reverse was found (25% adults vs. 75% immature in 1998 and 56.7% adult vs. 43.4% immature in 1999; $\chi^2_1 = 7.58$, $P < 0.001$).

In 2000 there were no systematic observations, but the presence of birds in the area of the roost was positively confirmed. The last observation of birds using the roost was on 7 June 2000, when 11 individuals were present. Later checks in July and August confirmed the absence of the species in the roost.

DISCUSSION

The first Egyptian Vultures were present at the roost approximately one and a half months after they arrived at the breeding grounds (beginning of March). This coincides with the species' incubation period, because laying usually takes place during the first half of April (Donázar 1993, pers. observ.). The birds seen in the first period were mostly adults; immatures joined the roost progressively at a later stage. The fact that the largest number of adults present were found in June (during the chick-rearing period) might correspond to their need to optimize foraging efficiency on food sources that are predictable in both space and time (Ceballos and Donázar 1988). On the other hand, adult birds that had failed in their breeding attempts and that had subsequently joined the roost might also cause this increase in numbers. The larger proportion of immature birds from May onward might be due to the late arrival of those non-breeding migrants, as has been suggested by Ceballos and Donázar (1990).

In this species, roosts may play a strong socialization role, as has been suggested in Black Vultures (*Coragyps atratus*; Parker et al. 1995). Associations are favored because they facilitate advantages in food finding and advantages in accruing coalition members in contests over food (Rabenold 1987, Parker et al. 1995). Social organization could facilitate the evolutionary stability among communally-roosting birds, but more data on this topic are needed.

Contrary to the dynamics observed in other Spanish roosts, where there is a progressive increase in birds from

June–August (Ceballos and Donázar 1990, Donázar et al. 1996), in the roost that we studied, the largest number of birds was found in June of both years. The decrease in the number of birds present in July and August, much higher in 1999, might be linked to a progressive decrease in food availability in the area and by the increase in the availability in food resources in neighboring zones (e.g., Ebro valley). Low food availablity would have caused the displacement of birds to richer areas. In fact, the small numbers of birds observed in August–September 1999 was due to the fact that the food source they had been exploiting was progressively reduced (between March and May rubbish was dumped at the landfill site once a week, while between June and September no rubbish was dumped). Also, no food was available at all in July 2000 (pers. observ.). This lack of food, which would partly explain the observed differences in temporal pattern with respect to other roosts, may also explain the absence of observations of young of the year. These juveniles, having left their nests between the end of July and the beginning of August, did not visit the roost. Our results also differ from those obtained in island population; where, due to the species' sedentary habits, the largest concentrations take place in the period between October and February (de Pablo 2000, Donázar et al. 2002).

There seems to be a link between roosts that would be due to a socializing component in this behaviour rather than to food availability (Donázar et al. 1996). Even though use of roosts is dynamic and birds do visit other roosts in the same year, we believe that the disappearance of the roost was caused by the progressive decrease and total disappearance of the available food source. The formation of this roost coincided with the appearance of a food source that was available regularly in space and time (Margalida 1997), a factor that has also been recorded in other Spanish roosts (Ceballos and Donázar 1990, Donázar et al. 1996). The roost under study disappeared when no more food was available at the rubbish dump the birds had been exploiting. The roost was located on trees that were close to the food source and in an area with little human disturbance. These factors might have determined the selection of the specific roost site (Ceballos and Donázar 1990). However, contrary to other roosts located on isolated trees (Ceballos and Donázar 1990, Donázar et al. 1996) this selection did not occur until one year after the roost was formed. Our observations suggest that the formation and exact location of the roost might undergo a spatial selection process that would end in the choice of the most appropriate location.

Conservation Problems. The Egyptian Vulture roost we studied was formed in 1997 and disappeared in June 2000 just as the food source ceased to exist. This factor accounts for the disappearance of other roosts in Spain (Tella 1991), which shows the species' strong dependency on these roost sites and the importance that maintaining them may have in terms of conservation.

The species has undergone a 30% decline in the last 20 years in Spain (J. Donázar pers. comm.), so urgent measures are needed to reverse this trend. Egyptian Vulture survival might be closely linked to the maintenance and protection of roost sites, which are typically in quiet areas and close to predictable food sources (Ceballos and Donázar 1990, Tella 1991, Margalida 1997). A large part of the population decline might be due to the appearance of a nonnatural mortality factor such as poison. Protection of these areas is thus key to the conservation of the species. Also an important part of the non-breeding population concentrates at these roosts and exploits the available food. It is essential to protect the areas where the roosts are located and to maintain the food sources to which they are associated, as our results suggest that the roost will remain as long as there is an abundant and regular food supply. For this reason, solutions must be found that allow for the coexistence of the necessary sanitary regulations of waste dumps and the conservation needs of scavenging raptors (see Tella 2001).

Resumen.—Describimos la dinámica y variación temporal en la estructura de edades de un dormidero comunal de Alimoches en Cataluña. La formación y desaparición del dormidero coincidió con la aparición y desaparición de la fuente de alimento. El dormidero se formó a menos de 2 km de la fuente predecible de alimento de la cual se abastecían y cambió en varias ocasiones su ubicación Los primeros individuos ocuparon el dormidero a finales de abril y las máximas concentraciones se produjeron en junio. Debido a la regresión sufrida por la especie durante los últimos 20 años y la importancia que tienen estos lugares para su conservación, es necesario proteger estos emplazamientos y compatibilizar la normativa sanitaria con el mantenimiento de los puntos de alimentación de los que dependen.

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DIET OF THREE SYMPATRIC OWLS IN STEPPE HABITATS OF EASTERN KAZAKHSTAN

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KEY WORDS: *Eurasian Eagle-Owl;* Bubo bubo; *Little Owl;* Athene noctua; *Long-eared Owl;* Asio otus; *Asia; diet; steppe habitats.*

We studied the diet and food-niche overlap of three sympatric owls, the Eurasian Eagle-Owl (*Bubo bubo*), the Long-eared Owl (*Asio otus*) and the Little Owl (*Athene noctua*), during the breeding season in semiarid steppe habitats of eastern Kazakhstan and compared their food habits with other localities in the western Paleartic. These remote steppe habitats have been little studied and their breeding raptor communities resemble those of Mediterranean Europe.

STUDY AREA AND METHODS

The study was conducted between 12 and 28 June 1999 in eastern Kazakhstan in central Asia. The climate is continental, with very cold winters (when temperatures remain under 0°C for months), and warm summers. Such conditions can also be considered as arid or semiarid with annual rainfall <300 mm. Extreme temperatures and rainfall limit the growth of tree species (Walter 1981) and the landscape is dominated by steppe and semidesert

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